

DETERMINATION OF EMISSIONS FROM THE MINERAL EXTRACTING INDUSTRY

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ABSTRACT

Federal and State laws require air agencies to prepare and maintain a current and accurate emissions inventory of all point and area sources. To achieve this goal the Mojave Desert Air Quality Management District (MDAQMD) has prepared a guidance document entitled “Determination of Emissions From The Mineral Extracting Industry” and Microsoft Excel spreadsheets for the determinations the emissions from the Mineral Extracting Industry (quarries and surface mining operations).

The guidance document was developed to ensure that these common operations and processes have their emissions estimated consistently. Consistency is important for two reasons: accuracy and fairness. The MDAQMD emissions inventory as a whole will be more accurate if every process of a given type has its emissions estimated using the same methodology (as opposed to a myriad of methodologies of unknown or questioned accuracy). Actions taken by the MDAQMD that depends on the emissions inventory (such as attainment plans and the rules that implement them) will be fairly applied if all processes are represented in the emissions inventory in the same manner.

INTRODUCTION

The MDAQMD chose the Mineral Extracting Industry because it is the dominant industry in terms of emissions and number of permit units within the MDAQMD. The Mineral Extracting Industry performs a number of similar operations associated with extracting minerals from the Earth’s crust and processing them. Aside from equipment and material differences, these operations and processes are essentially the same from facility to facility. Accordingly, the MDAQMD has prepared this guidance document to ensure that these common operations and processes have their emissions estimated consistently throughout the region. Operations and processes covered include drilling, blasting, handling, hauling, unpaved and paved roadway, stationary and mobile combustion sources, stockpiles, crushing and screening circuits, and stockpiles.

The guidance documents present methodologies for a large number of emissions generating operations and processes. The methodologies provide several levels of increasing complexity and accuracy. Each level of increased complexity will require greater input (and effort) from the user. In practice, this means that an equation is provided for each process, with a variety of default equation inputs specified. At the lowest level of complexity, the specified emission factor can simply be multiplied by a process activity rate. The greatest level of complexity and accuracy involves the use of material characteristics (moisture, density, silt content, etc.), local meteorological data (wind speed, evaporation, etc.), source test data, and/or continuous emission monitor (CEMS) data.

This attempt to impose uniformity to improve accuracy should not be construed as a criticism of existing inventories or methodologies. On the contrary, the MDAQMD staff greatly appreciates the efforts of the many individuals who have created the existing methodologies and used them to estimate emissions. Also, the MDAQMD staff does not claim to have the most accurate emission inventory; rather, the MDAQMD staff is attempting to establish a minimum level of known accuracy. Methodologies more accurate than those presented herein will be accepted. Other methodologies may be accepted, if they have been documented and approved by the MDAQMD. As new, modified, or improved methodologies become available the MDAQMD will review them. If the methodologies are found to be applicable the guidance document and electronic spreadsheets will be revised.

The guidance document will be accompanied by a set of electronic spreadsheets that contains each of the equations used in these methodologies. These allow the user to 'plug-in' facility specific values and calculate facility specific results. The electronic spreadsheets are currently being revised to repair bugs and errors found during recent field usage.

Most of the equations used in the guidance document were taken from the "Compilation of Air Pollution Emission Factors" (AP-42); the supporting documents used to develop AP-42; and Air & Waste Management Association "Air Pollution Engineering Manual", 1992 edition.

The emission estimates that are generated by this guidance documents are only as good as the data used to generate the equations and facility specific data that is used.

BODY

Guidance Document

The guidance document presents methodologies for a large number of emissions-generating operations and processes. The methodologies will be provided with several levels of increasing complexity and accuracy; each level of increased complexity will require greater input (and effort) from the user. In practice, this means that an equation is provided for each process, with a variety of default equation inputs specified. At the lowest level of complexity, an emission factor is specified that can simply be multiplied by a process activity or throughput rate.

The greatest level of complexity and accuracy involves the use of data from a source test (if feasible). Of course, the MDAQMD would prefer all emission inventories to be based on site-specific source test results or continuous emission monitor (CEMS) data. However, this is not feasible due to obvious cost and time constraints. A properly performed and documented source test (and/or CEMS data) provides the greatest accuracy possible, and most always will be accepted in lieu of a methodology presented herein. Other methodologies will be accepted, if they have been documented and approved by the MDAQMD.

The guidance document will be accompanied by a set of electronic spreadsheets that contains each of the equations used in these methodologies. These equations will have the MDAQMD approved default values. The user will be allowed to replace the default value with site-specific value and to 'plug-in' facility specific throughput and activity data. This will result in a site-specific emission inventory.

Source Test Data

For source test results to be used to generate an emission factor additional emissions and activity related information is required. In order to generate a set of equipment-specific emission factors based upon source test result the following supplemental information must accompany the source test report:

- A. Process flow diagram that specifies pickup points
- B. Control equipment description that defines operational parameters during test (such as water pressure and flow rate, pressure drop across control device, etc).
- C. Throughput during test in hourly units (or shorter term units), including a discussion of maximum design throughput, average throughput, and actual throughput during the test.
- D. Exhaust concentrations and mass emission rates, including front half, back half, and total emissions. The concentrations and mass rates should identify values for total hydrocarbon, reactive organic gases and volatile organic compounds. The concentrations and mass rates should also identify values for total suspended particulate, particulate 10 microns and less, and particulate 2.5 microns and less.

Methodologies

Each methodology will be presented in the same format. The methodology will begin with a detailed discussion of the processes and operations for which it is an applicable emissions estimation methodology. The methodology itself will then be provided, beginning with the most conservative and least complex version, and followed by increasingly complex and data-intensive versions. Each methodology will culminate with the complete equation (where possible), for which the user has the option of providing all inputs. The MDAQMD has prepared tables calculating likely values for various common inputs. Each methodology contains a discussion of applicable control strategies (where possible), and appropriate calculation methods for those. Each methodology concludes with a source reference.

This paper does not contain the equation or detail references, which can be found in the document entitled “Mojave Desert Air Quality Management District - Antelope Valley Air Pollution Control District - Emissions Inventory Guidance -Mineral Handling and Processing Industries”. A copy of the documents and spreadsheets will be available from the MDAQMD once the current revisions are completed.

Because of the length of the guidance document only the first methodology is presented in the paper in its full format followed by a summary of each of the other methodologies.

A - Blast Hole Drilling

This methodology applies to the drilling of charge holes for open pit or open shelf blasting. Note that the activity input for the equation requires the total amount of material shifted, including, topsoil, overburden and ore. Portable internal combustion engine powered drills often perform blast hole drilling; exhaust emissions from this equipment are not accounted for by this method. Such exhaust emissions should be estimated using methods presented elsewhere.

“Shifted” is defined as loosened sufficiently to require removal or further handling.

Least Complex:

A facility shifting less than 50,000 tons per year of ore, overburden and topsoil combined can assume negligible particulate emissions from blast hole drilling.

Intermediate Complexity:

This method employs a conservative emission factor that is multiplied by the amount of material shifted by blasting.

$$\text{Equation (1)} \quad E = E_f \times Q$$

where

E = Particulate matter emissions rate in pounds per year

E_f = Emission factor in units of pounds of particulate per ton shifted by blasting

TSP E_f = 0.001 pounds/ton

PM₁₀ E_f = 0.0008 pounds/ton

PM_{2.5} E_f = 0.0008 pounds/ton

Q = Amount of material of all types shifted by blasting during the year in tons

Blast Hole Drilling Table 1 – Blasting Activity Based Emissions									
Activity in tons (yearly)	50000	75000	100000	125000	150000	175000	200000	225000	250000
TSP Emissions (tons)	0.03	0.04	0.05	0.06	0.08	0.09	0.10	0.11	0.13
PM10 Emissions (tons)	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10
PM2.5 Emissions (tons)	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.10

Most Complex:

This method requires an estimate of the number of shot holes drilled on an annual basis.

$$\text{Equation (1)} \quad E = E_f \times N$$

where

E = Particulate matter emissions rate in pounds per year

E_f = Emission factor in units of pounds of particulate per hole drilled

TSP E_f = 1.3 pounds/hole

PM₁₀ E_f = 0.68 pounds/hole

PM_{2.5} E_f = 0.68 pounds/hole

N = Number of blast holes drilled per year

Blast Hole Drilling Table 2 – Drilling Activity Based Emissions														
Number of Holes (yearly)	100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400
TSP Emissions (tons)	0.07	0.13	0.20	0.26	0.33	0.39	0.46	0.52	0.59	0.65	0.72	0.78	0.85	0.91
PM10 Emissions (tons)	0.03	0.07	0.10	0.14	0.17	0.20	0.24	0.27	0.30	0.34	0.37	0.37	0.44	0.47
PM2.5 Emissions (tons)	0.03	0.07	0.10	0.14	0.17	0.20	0.24	0.27	0.30	0.34	0.37	0.37	0.44	0.47

Control Techniques:

None are presently quantified. The methods assume a wet drilling operation. Other control techniques include enclosures, air return or other control strategies can be employed. The estimated

control efficiency for other control techniques must be documented and will be subject to District review and approval.

Source:

The intermediate complexity method employs a low confidence emission factor presented in Chapter 15 of the Air & Waste Management Association Air Pollution Engineering Manual, 1992 edition (Stone and Quarrying Processing). The high complexity method employs a relatively highly rated emission factor derived from overburden drilling operations at western surface coal mines presented in §11.9 of USEPA's AP-42 (January 1995 reformatted version).

B - Dust Entrainment from Blasting

This methodology applies to the fracturing and loosening of topsoil, ore, overburden and substrate in open pits and open shelves through the use of explosives. Note that activity rates for this method require the total amount of material shifted through the use of blasting, including topsoil, overburden and ore. "Shifted" is defined as loosened sufficiently to require removal or further handling.

C - Criteria Emissions from Blasting Explosives

This methodology estimates the criteria pollutants generated by the detonation of explosives for blasting. This is a "least complex" method that multiplies an emission factor by the total amount of explosives detonated in a year.

D - Bulldozing, Scraping and Grading of Materials

This methodology applies to the bulldozing, scraping and grading of topsoil, overburden, waste material, and ore through the use of heavy equipment such as bulldozers, graders, scrapers, etc. This procedure does not apply to the lifting and dumping of said materials; such lifting and dumping emissions should be estimated using methods presented elsewhere.

E - Material Handling Operations

This methodology applies to the handling of materials in batches and conveyor belts, including loading, unloading, transferring and dropping. "Materials" include topsoil, overburden, waste material and ore. This procedure specifically applies to the operation of heavy equipment such as front-end loaders and shovels as well as conveyor belts. This procedure is intended to be applied to each material handling point. This means that each batch drop should be counted. For example, a loader dropping a quantity of material into a temporary storage pile, then dropping into a dump truck, then the dump truck dumping into a long-term storage pile would be three separate operations, which should be separately accounted for.

F. - Material Crushing and Screening Operations

This methodology applies to the crushing and screening of materials. This is effectively a "least complex" method that multiplies an emission factor by annual throughput. This method applies to each occurrence of a crushing or screening operation; in a process line with primary crushing and a screen, secondary crushing and a screen, and tertiary crushing followed by a screen, this method should be applied six times (to six potentially different throughputs).

G - Wind Erosion From Stockpiles

This methodology applies to wind erosion from open storage piles.

H - Stationary Equipment Exhaust

This methodology estimates exhaust from a wide variety of fuel-burning stationary equipment used in the mineral industry. This is a “least complex” method that multiplies an emission factor by annual fuel use, and should be used only if source test or manufacturer guaranteed emissions data is not available for the equipment in question. This method requires fuel type and annual fuel use as inputs. Boilers, Space Heaters, Generic Industrial Process Heaters, Internal Combustion Engines, and Gas Turbines are covered by this method.

I - Mobile Equipment and Vehicular Exhaust

This methodology estimates the exhaust and brake wear emissions from a variety of mobile equipment common in the mineral industry. Note that this method estimates exhaust from mobile equipment only, and dust entrainment due to the travel of mobile equipment on paved and unpaved surfaces should be estimated using the methods presented elsewhere in this document. This is effectively a “least complex” method that multiplies a conservative emission factor by annual activity in hours of use, fuel consumption in 1000’s of gallons, or travel in 1000’s of miles.

J - Dust Entrainment from Paved Roads

This methodology applies to all traffic on paved roads. This methodology estimates the dust entrainment due to vehicular travel on paved surfaces. Vehicular exhaust emissions should be estimated using methods presented elsewhere.

K - Dust Entrainment from Unpaved Roads

This methodology applies to all traffic on unpaved roads. This methodology estimates the dust entrainment due to vehicular travel on unpaved surfaces. Vehicular exhaust emissions should be estimated using methods presented elsewhere.

L - Wind Erosion from Unpaved Operational Areas and Roads

This methodology applies to actively disturbed unpaved areas, specifically including plant or operational areas (such as quarries) and roads. Actively disturbed is defined as being disturbed by man’s activity at least once per day. This methodology estimates the particulate emissions from these areas due to wind erosion. Particulate emissions due to actual vehicular travel on these areas should be estimated using methods presented elsewhere.

CONCLUSIONS

The “Determination Of Emissions From The Mineral Extracting Industry” is not the final word on how to determine emissions from quarries and surface mining activities, but is a way to determine emissions in a uniform way to allow comparisons from one facility to another facility. As improved or new methodologies become available the MDAQMD will review them. Before new or modified methodologies are incorporated into the guidance document it must be shown that the methodology was developed for or on a facility similar to those in this district and under conditions similar to those of a desert environment, 4 to 5 inches of rain per year, windy conditions, 100 plus degrees etc.

Where appropriate the MDAQMD is planning to add toxic emission calculations these methodologies.

REFERENCES

Compilation of Air Pollution Emission Factors, U. S. Environmental Protection Agency, Research Triangle Park, NC, January 1995; EPA-42

“External Combustion Sources”, Section 1

“Western Surface Coal Mining”, Section 11.9

“Aggregate Handling and Storage Piles”, Section 13.2.4

“Industrial Wind Erosion”, Section 13.2.5.

“Explosive Detonation”, Section 13.3

Compilation of Air Pollution Emission Factors, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1997; EPA-42

“Paved Roads” Section 13.2.1.

Compilation of Air Pollution Emission Factors, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1998; EPA-42

“Unpaved Roads”, Section 13.2.2.

Emission Inventory, Mojave Desert Air Quality Management District, fleet average emission factors.

Kinsey, J.S.; Cowhead, Jr., C., “Fugitive Emissions”, *Air Pollution Engineering Manual*, Buonicore, A.J.; Davis, W.T., Air and Waste Management Association, Van Norstand Reinhold, New York, 1992, Chapter 2, pp 133-146.

Yocom, J.E. “Sand and Gravel Processing”, *Air Pollution Engineering Manual*, Buonicore, A.J.; Davis, W.T., Air and Waste Management Association, Van Norstand Reinhold, New York, 1992, Chapter 15, pp 778-780.

Yocom, J.E. “Stone and Quarry Processing”, *Air Pollution Engineering Manual*, Buonicore, A.J.; Davis, W.T., Air and Waste Management Association, Van Norstand Reinhold, New York, 1992, Chapter 15, pp 780-787.

KEYWORD

Emission Inventories

PM

Stationary Sources

Mineral Extracting Industry

Quarries

Surface mining operations